GROUNDWATER MONITORING

JONES TRACT FLOOD
SACRAMENTO-SAN JOAQUIN DELTA, CALIFORNIA

Project No. 101.22
April 15, 2005

Prepared by

Hultgren – Tillis Engineers

A California Corporation
Specializing in Geotechnical Engineering

Hultgren-Tillis Engineers

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Department of Water Resources
901 P Street, 2nd Floor
Sacramento, California 95814

Attention: Mr. Tirath Pal Sandhu

Groundwater Monitoring
Jones Tract Flood
Sacramento-San Joaquin Delta, California

Dear Mr. Sandhu,

We monitored groundwater levels in piezometers related to the flooding and subsequent dewatering of Jones Tract. The results of the monitoring are presented in the attached report.

It was a pleasure working with you on this project. If you have any questions, please call.

Sincerely,

Hultgren – Tillis Engineers

Hugh D. Davis
Civil Engineer

R. Kevin Tillis
Geotechnical Engineer

RKT:HDD:EMH:la

6 copies submitted

File No. 10122R01

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I. INTRODUCTION

This report presents the results of the monitoring of groundwater levels in six piezometers at or near Upper Jones Tract and Lower Jones Tract (Jones Tract). Jones Tract flooded due to the failure of a section of Middle River levee on Upper Jones Tract in June 2004. Following the repair of the levee, the water that inundated the island was pumped out between about July 12, 2004 through December 18, 2004.

We monitored the groundwater levels at five existing standpipe piezometers and one new standpipe piezometer located around the vicinity of Jones Tract during and following pumping operations. One piezometer was located on Upper Jones Tract (UJ-21), and two piezometers each on Woodward Island (WO-26 and WO-27) and Palm Tract (PA-29 and PA-30). These five piezometers were drilled and installed as part of the Delta Wetlands project. The new piezometer is on Bacon Island (BA-35). The locations of the site and the six piezometers are shown on Plates 1 through 3. The locations and elevations of the piezometers are also presented in the table below. The Department of Water Resources (DWR) surveyed the locations and elevations of each piezometer.

Island	Piezometer Number	Location (feet)		Elevation Top of Piezometer Casing (feet, 1929 NGVD)
		Northing	Easting	
Upper Jones Tract	UJ-21	2163221	6265561	6.09
Bacon Island	BA-35	2172616	6264699	8.44
Woodward Island	WO-26	2157366	6268446	-5.56
Woodward Island	WO-27	2166049	6260697	-1.92
Palm Tract	PA-29	2177872	6248744	9.64
Palm Tract	PA-30	2174672	6252562	11.03

Piezometers UJ-21, BA-35, WO-26 and WO-27 are located within the levee crest. Piezometer WO-27 is located about mid-slope of the landside levee face and WO-26 is located near the landside levee toe. The piezometers on Palm Tract are far removed from Jones Tract. We chose to monitor the Palm Tract piezometers to collect data on background water levels that would not be affected by the dewatering of Jones Tract.

Our scope of services was outlined in our proposal dated July 19, 2004 and Service Agreement dated June 25, 2004 and Amendment 1 dated October 10, 2004. Our scope of services included installing one new standpipe piezometer on Bacon Island, installing vibrating wire piezometers in this standpipe piezometer and in five existing standpipe piezometers, recording the groundwater elevations during and following the dewatering of Upper and Lower Jones Tracts and presenting the data. The groundwater data is presented in this report.

II. FIELD EXPLORATION AND INSTRUMENTATION

We drilled one boring and installed a standpipe piezometer on Bacon Island on July 26, 2004. The location is shown as BA-35 on Site Plan 1, Plate 2.

The boring was drilled with a truck-mounted, CME-45 drill rig using wet rotary drilling methods. Samples were collected with a 2.5-inch outside diameter (O.D.) / 1.9-inch inside diameter (I.D.) sampler and a 2.0-inch O.D. / 1.4-inch I.D. standard penetration test (SPT) sampler. The samplers were driven with an automatic hammer system for a penetration depth of 18 inches. Our engineer recovered samples from the boring and returned them to our office for further examination. The Log of Boring BA-35 is presented on Plates 4 and 5. The soil descriptions are presented in general accordance with the Soil Classification System shown on Plate 6.

The boring was converted to a standpipe piezometer. The piezometer consists of 2-inch diameter PVC pipe placed in the borehole. The lowest 10 feet of the piezometer was screened between 39 feet to 49 feet below the levee crest. The remainder of the casing is blank (solid wall) PVC. The annular space between the borehole wall and the pipe was filled with sand from the bottom of the hole to about 2 feet above the top of the screen, followed by bentonite chips and then neat cement grout to near the top of the standpipe.

The existing and new piezometers screen a portion of the sand formation that underlies the peat. The piezometers are intended to measure the groundwater pressure (head) within the sand. A vented vibrating wire piezometer was placed in each of the six standpipe piezometers. The vibrating wire piezometer was connected to a mini-logger from Durham Geo Slope Indicator Company. The groundwater levels were measured once per hour and stored in the mini-logger. We periodically downloaded the data to a laptop computer.

III. DISCUSSION AND CONCLUSIONS

A. Site Conditions

Upper and Lower Jones Tracts and the surrounding islands are former marsh areas that were reclaimed approximately a century ago. The perimeter of the islands include flood control levees constructed on the marsh soils. The island interiors typically consist of peat and other marsh deposits underlain by sand. The island interiors have subsided since reclamation and are now well below sea level.

The sand below the peat is present below many islands and is believed to be contiguous, extending beneath existing sloughs and rivers to neighboring islands. Under typical Delta conditions, the water infiltrates from the tidal sloughs and rivers into the island interiors through the sand layer. The water surface in the slough is typically 15 to 20 feet above the interior island ground surfaces, and the groundwater levels are typically maintained a few feet below the ground surfaces within the islands.

Jones Tract flooded in June of 2004. The flooding of Jones Tract changed the hydrologic conditions beneath Jones Tract. When flooded, the groundwater level beneath Jones Tract rose from slightly below the ground surface to the levels in the adjacent slough. Seeps developed within fields on adjacent islands.

Existing piezometers were present on the adjacent properties and provided an opportunity to check the impacts of island flooding on groundwater levels beneath neighboring islands. The data collected from the piezometers began after Jones Tract had flooded and the levee break area closed. The data presented in this report covers the period from about one month after Jones Tract flooded to about three months after the water within the island had been pumped out. The data reflects impacts at the existing piezometers from removal of water.

B. Results

The program is intended to monitor the effect that the changes in the groundwater level on Jones Tract had on the groundwater levels of adjacent islands.

The height of the floodwater at Jones Tract was measured and recorded by DWR from the start to end of pumping operations (July 12, 2004 through December 18, 2004). We

understand that the drawdown was measured relative to the invert elevation of a pipe. The data is shown on Plate 7. The data shows a near constant rate of drawdown from July 12, 2004 through about September 12, 2004. From September 12 through about November 4, 2004, the drawdown rate decreased. The rate then increased to above the initial rate to December 6, 2004. From December 6, 2004 until December 9, 2004 the water level is shown rising which probably reflects storm water runoff. After December 9, 2004 the water level continued to be lowered until the water was removed from the island interior.

Pumping on Jones Tract had a direct affect on the groundwater level within Piezometer UJ-21, located on the Upper Jones Tract levee. The magnitude of drawdown within UJ-21 was about 9 feet, after which groundwater recharge from the adjacent Middle River controlled. Though the magnitude of drawdown in the piezometer is less than within the island, the drawdown pattern is similar to drawdown of water within Jones Tract. The groundwater elevation data from UJ-21 is shown on Plate 8 and a comparison with the Jones Tract drawdown is shown on Plate 14. The groundwater data is presented along with a line showing the 100-point running average of the data.

BA-35 on Bacon Island and WO-26 on Woodward Island also show a response to the lowering of the water level on Jones Tract. The pattern of drawdown is similar to the Jones Tract drawdown and drawdown in UJ-21. The groundwater level within BA-35 went down about 1.5 feet and the groundwater level within WO-26 went down about 2 feet during the time of water removal from Jones Tract. The data from BA-35 is shown on Plate 9 and the data from WO-26 is shown on Plate 10. The data from BA-35 and WO-26 is shown with the data from UJ-21 on Plate 15.

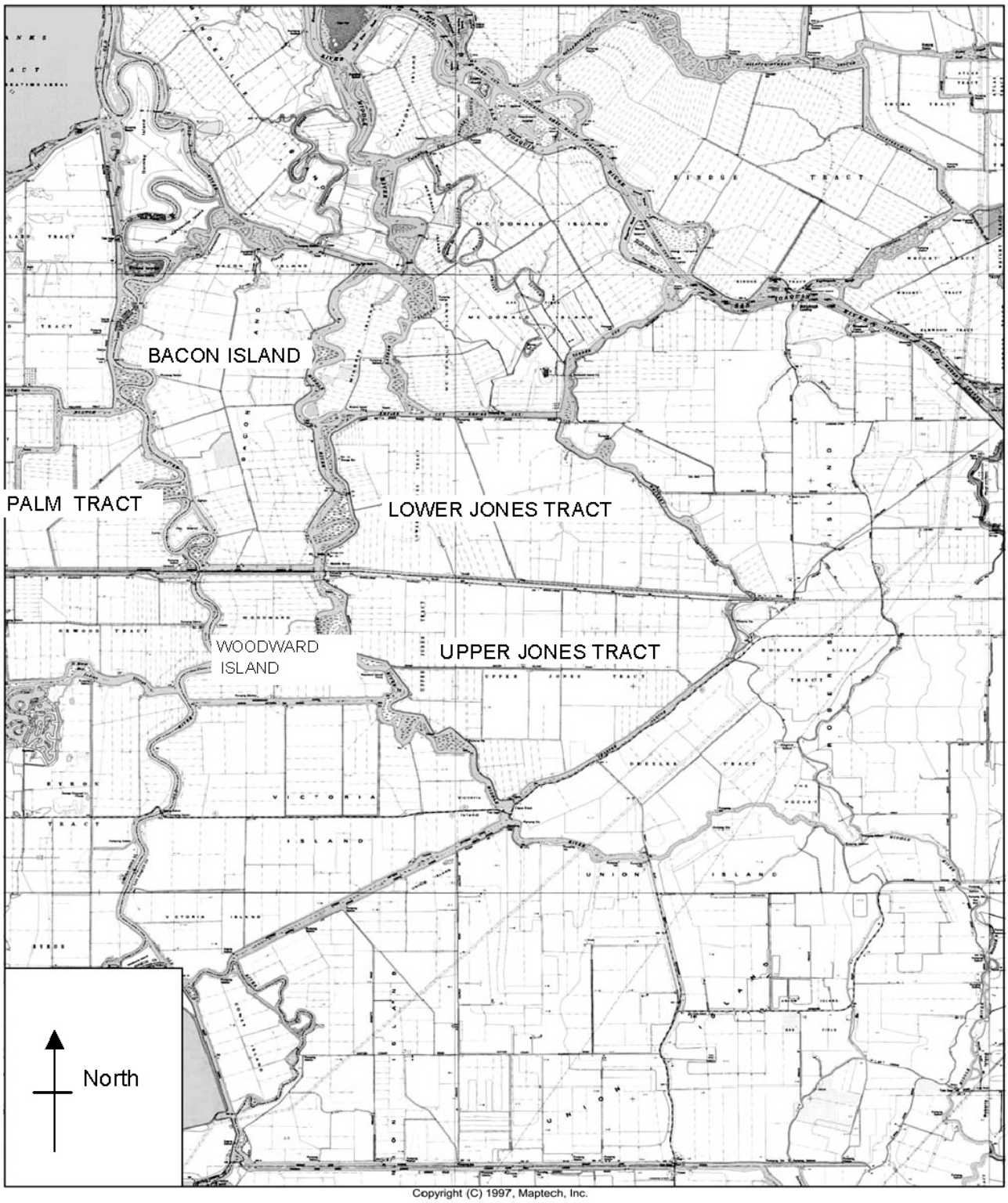
The groundwater levels within WO-27 on Woodward Island and PA-29 and PA-30 on Palm Tract did not show a response to the drawdown of water on Jones Tract. The data is shown on Plates 11 through 13 and compared to the data from UJ-21 on Plates 16 and 17.

C. Conclusions

The flooding of Jones Tract raised the groundwater levels within the footprint of Upper Jones Tract and Lower Jones Tract to near mean tide elevation. The groundwater data presented in this report shows that the groundwater levels were raised 1½ to 2 feet in the sand layer at two piezometers on Woodward Island and Bacon Island (both nominally 300 meters

from Jones Tract) as a result of the flooding of Jones Tract. No impact was observed in piezometers located nominally 1,000 meters (WO-27) or at 3.7 to 5 kilometers (background piezometers on Palm Tract).

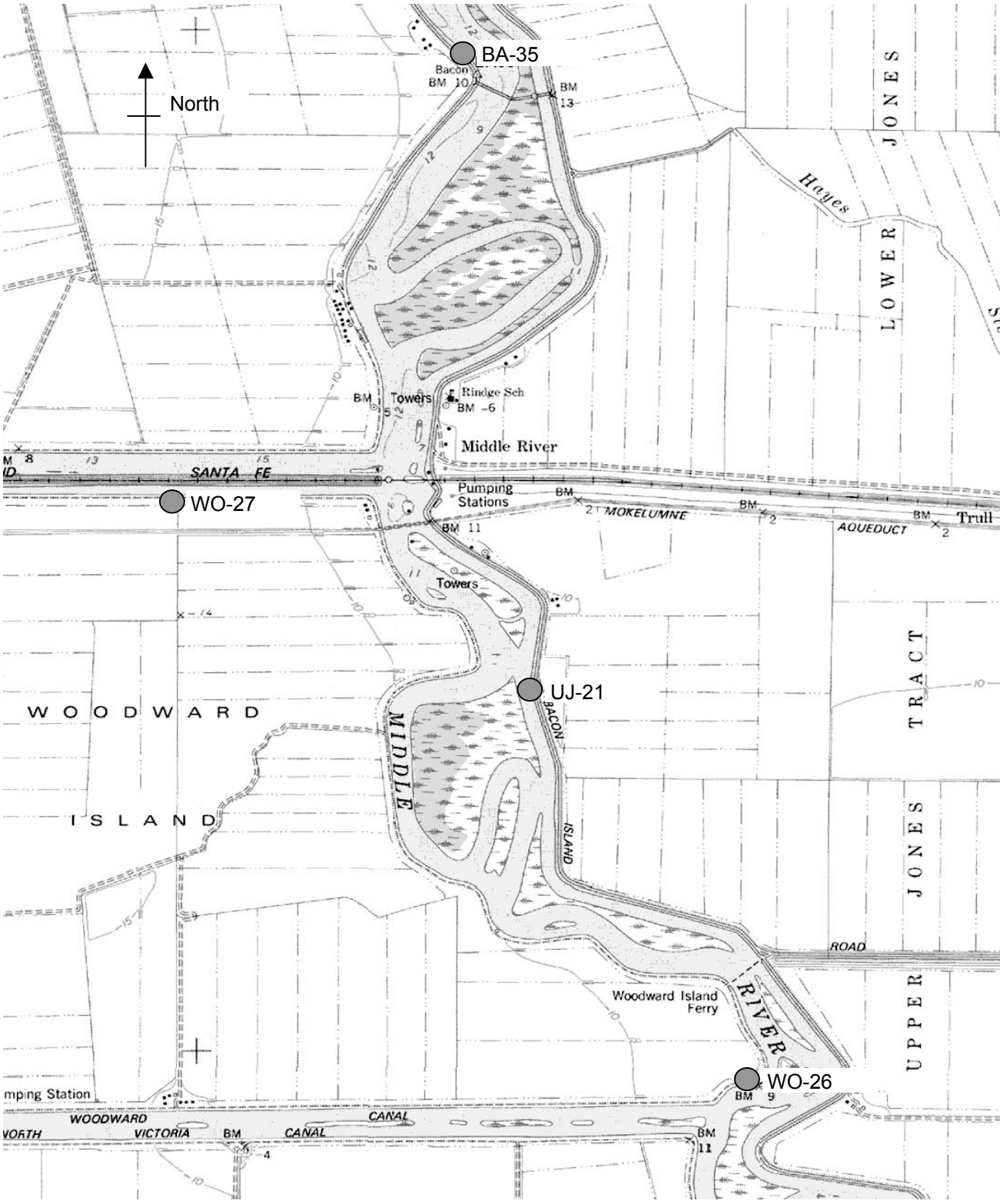
PLATES



Not to Scale

Groundwater Monitoring *Jones Tract Flood* *Sacramento-San Joaquin Delta, California*	**Vicinity Map**

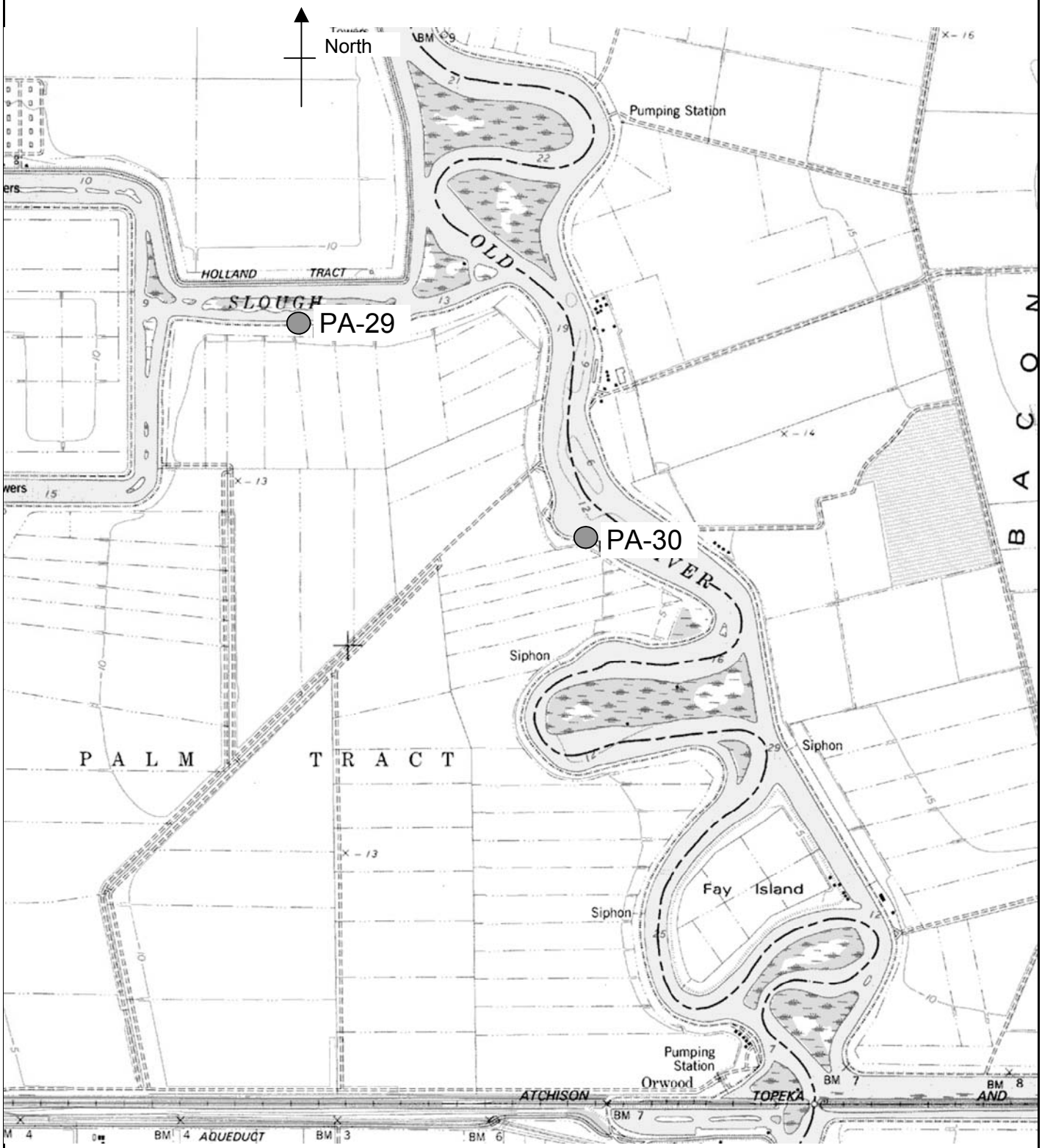
Hultgren - Tillis Engineers	Project No. 101.22	Plate No. 1



Approximate Location of Monitoring Wells

Not To Scale

	Groundwater Monitoring *Jones Tract Flooding* *Sacramento-San Joaquin Delta, California*	**Site Plan 1**
Hultgren - Tillis Engineers	Project No. 101.22	Plate No. 2



Approximate Location of Monitoring Wells

Not To Scale

Groundwater Monitoring *Jones Tract Flood* *Sacramento-San Joaquin Delta, California*	**Site Plan 2**

Hultgren - Tillis Engineers	Project No. 101.22	Plate No. 3

Hultgren-Tillis Engineers

LOG OF BORING BA-35

Date Drilled : July 26, 2004
Drilling Method : Hollow Stem
Elevation (Feet) : 8.44 (NGVD 1929 Datum)
Northing : 2172615.53
Easting : 6264699.13

Jones Tract Flood
Sacramento-San Joaquin Delta, California

Project No. 101.22 Plate 4

Sampler Type: SPT; 2.5-inch; 3.0-inch; Shelby Tube

Water Levels: During Drilling; After Completion

Depth in Feet	Samples	Blow Count	Graphic	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Penetrometer (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
0				ML		Gray Gravel Brown Sandy Silt (ML) with gravel, medium stiff, moist (Fill)					
5		2		MH-SP	▼	Gray Elastic Silt (MH) and Brown Poorly Graded Sand (SP), soft, moist (Fill) 07/26/04	0.13				
10		2		MH		Gray Elastic Silt (MH) with peat, soft, saturated					
15		2		MH-Pt		Gray Elastic Silt (MH) and Brown Peat (Pt), medium stiff, saturated	0.31				
20		2		MH		Gray Elastic Silt (MH) with brown organics, soft, saturated	0.19				
25		12		ML		Gray Sandy Silt (ML) with brown organics, soft, saturated					
30		5		SM		Gray Silty Sand (SM), medium dense, saturated					
35											

Hultgren-Tillis Engineers

LOG OF BORING BA-35

Date Drilled : July 26, 2004
Drilling Method : Hollow Stem
Elevation (Feet) : 8.44 (NGVD 1929 Datum)
Northing : 2172615.53
Easting : 6264699.13

Jones Tract Flood
Sacramento-San Joaquin Delta, California

Project No. 101.22 Plate 5

Sampler Type: SPT; 2.5-inch; 3.0-inch; Shelby Tube

Water Levels: During Drilling; After Completion

Depth in Feet	Samples	Blow Count	Graphic	USCS	Water Levels	Material Description	Torvane (tsf)	Pocket Penetrometer (tsf)	Moisture Content (%)	Dry Density (pcf)	Other Laboratory Tests
35											
		20				Gray Silty Sand (SM), medium dense, saturated					
40		7				becoming loose					
45		11		SM		becoming medium dense					
50		10									
55				CL		Blue-Gray Lean Clay (CL), medium stiff, saturated					
60		8									
						Bottom of boring at 61.5 feet Boring converted to piezometer					
65											
70											

MAJOR DIVISIONS				GROUP NAMES
COARSE-GRAINED SOILS (MORE THAN 50% RETAINED ON NO. 200 SIEVE)	GRAVELS (MORE THAN 50% OF COARSE FRACTION IS RETAINED ON No. 4 SIEVE)	CLEAN GRAVELS (WITH LESS THAN 5% FINES)	GW	WELL-GRADED GRAVEL
			GP	POORLY GRADED GRAVEL
		GRAVELS (WITH OVER 12% FINES)	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SANDS (50% OR MORE OF COARSE FRACTION PASSES No. 4 SIEVE)	CLEAN SANDS (WITH LESS THAN 5% FINES)	SW	WELL-GRADED SAND
			SP	POORLY GRADED SAND
		SANDS (WITH OVER 12% FINES)	SM	SILTY SAND
			SC	CLAYEY SAND
FINE-GRAINED SOILS (50 PERCENT OR MORE PASSES NO. 200 SIEVE)	SILTS AND CLAYS (LIQUID LIMIT LESS THAN 50)		ML	SILT
			CL	LEAN CLAY
			OL	ORGANIC CLAY, ORGANIC SILT
	SILTS AND CLAYS (LIQUID LIMIT 50 OR MORE)		MH	ELASTIC SILT
			CH	FAT CLAY
			OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			Pt	PEAT

UNIFIED SOIL CLASSIFICATION SYSTEM- ASTM D 2487

Perm	- Permeability		TxUU	Shear Strength (psf)	- Unconsolidated Undrained Triaxial Shear
Consol	- Consolidation		TxCU	Shear Strength (psf)	- Consolidated Undrained Triaxial Shear
LL	- Liquid Limit (%)		UC	Compressive Strength (psf)	- Unconfined Compression
PI	- Plasticity Index (%)				
Gs	- Specific Gravity				
Sieve	- Particle Size Analysis				
P	- Push				

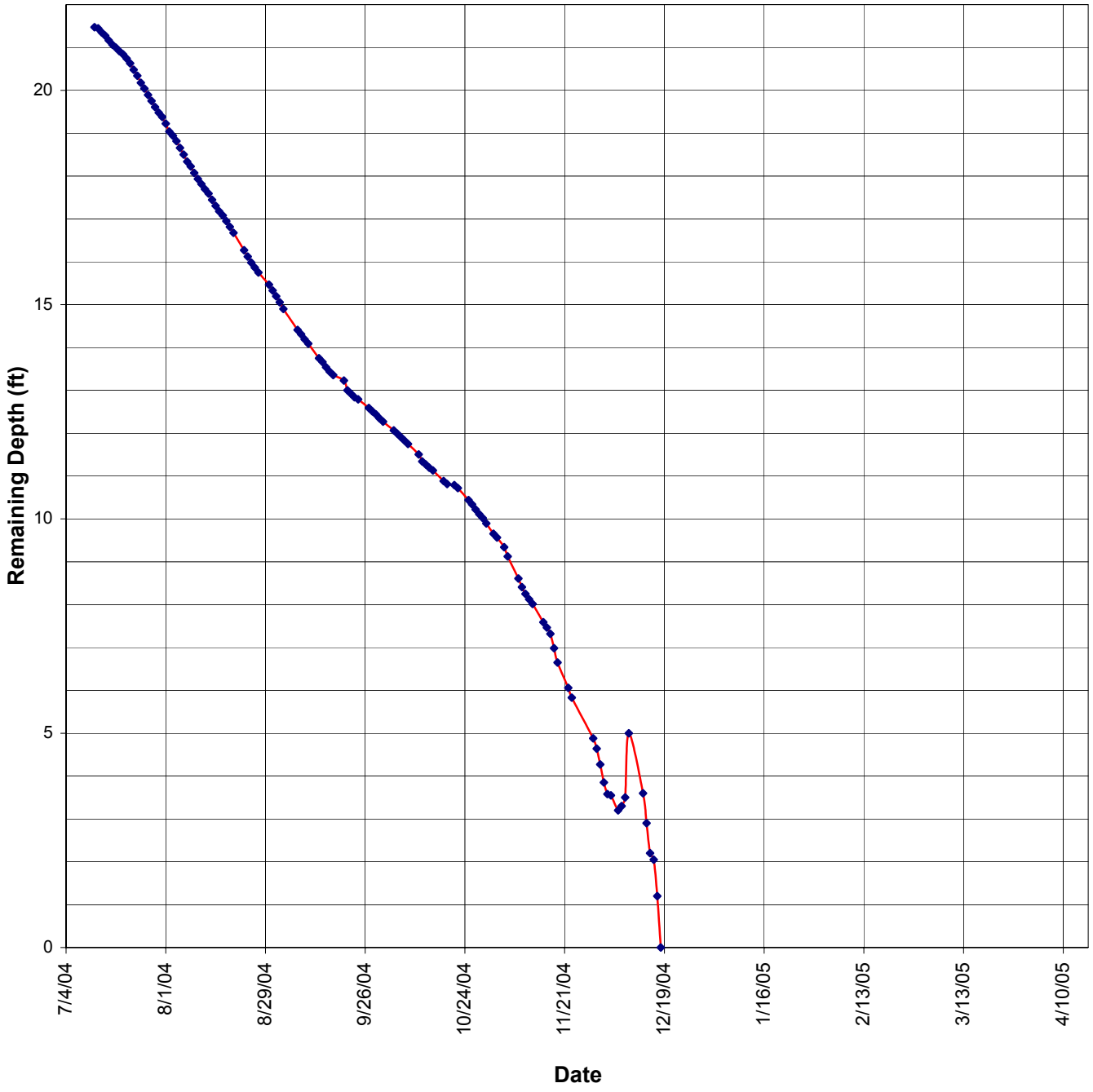
KEY TO TEST DATA

Groundwater Monitoring
Jones Tract Flood
Sacramento -San Joaquin Delta, California

Soil Classification Chart

Hultgren - Tillis Engineers | Project No. 101.22 | Plate No. 6

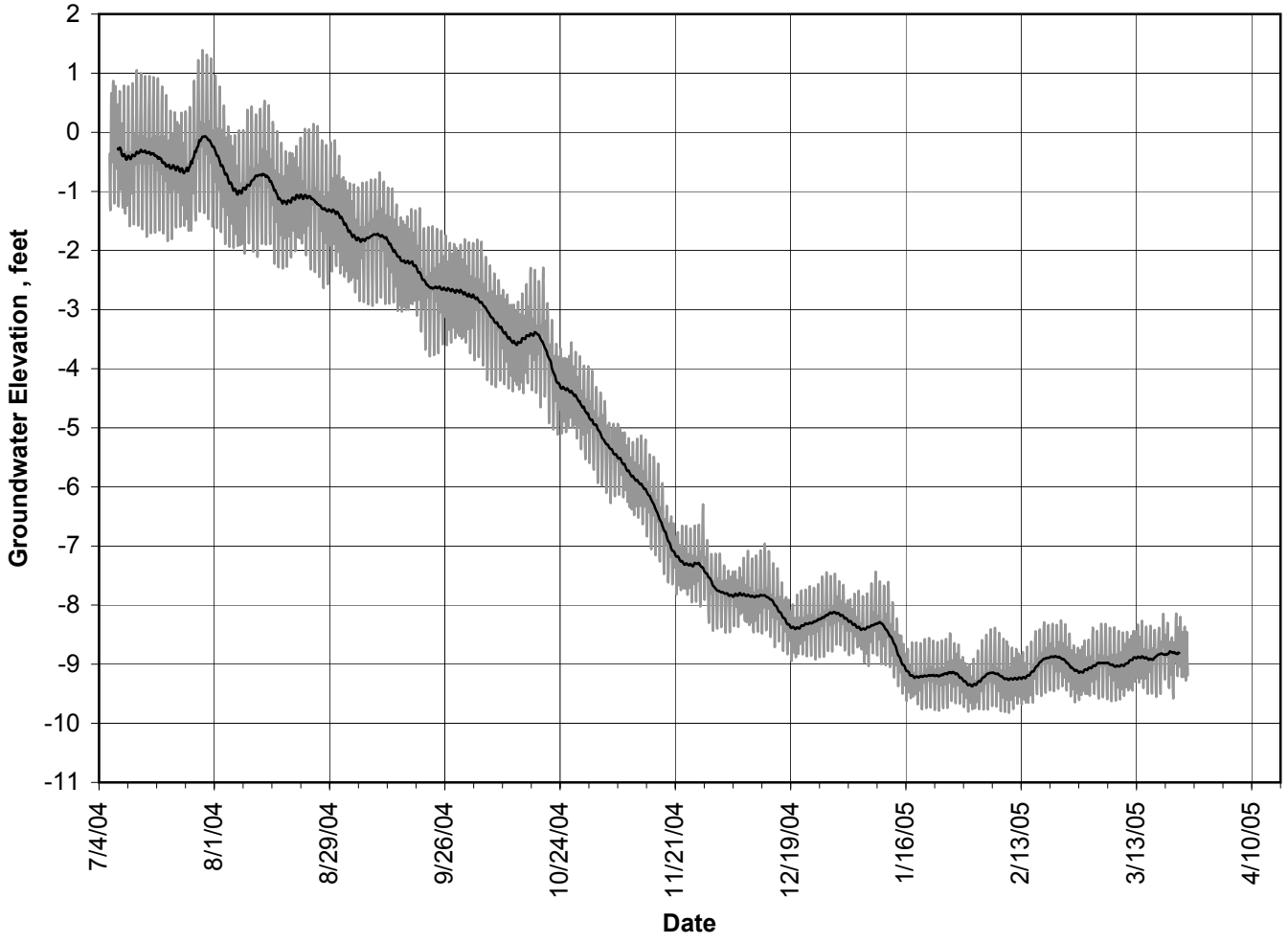
Jones Tract Water Level



Notes:
(1) Data provided by DWR

Groundwater Monitoring *Jones Tract Flood* *Sacramento-San Joaquin Delta, California*	**Jones Tract Water Level**	
Hultgren - Tillis Engineers	Project No. 101.22	Plate No. 7

Piezometer - Upper Jones Tract - UJ-21



TYPICAL LEGEND (for all charts)

Collected Data — 100 pt. Running Average

Notes:

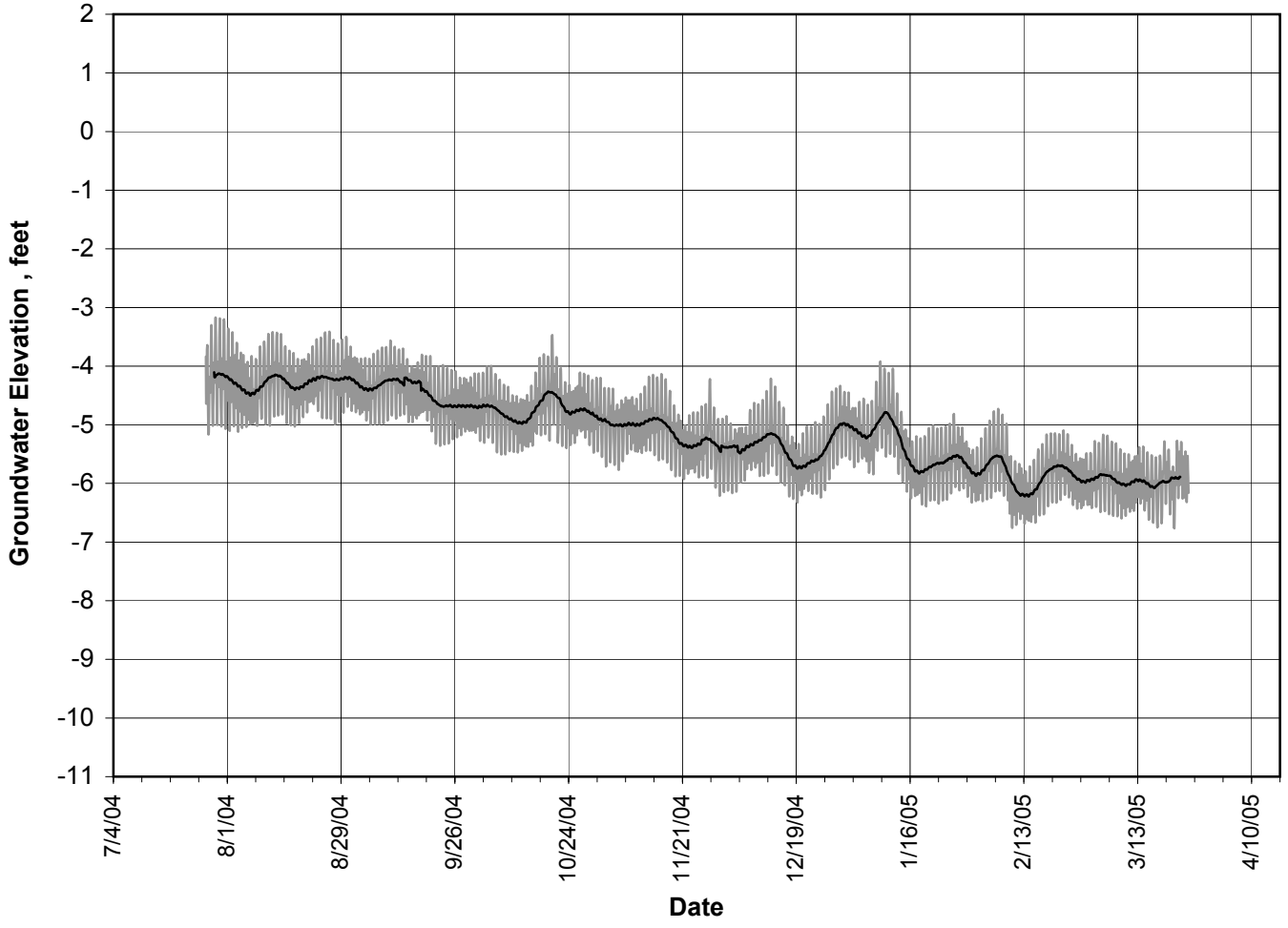
(1) Elevations referenced to 1929 NGVD

(2) Groundwater levels measured inside standpipe with vibrating wire piezometer and data logger

Groundwater Monitoring *Jones Tract Flood* *Sacramento-San Joaquin Delta, California*	**Groundwater Data at Piezometer UJ-21**

Hultgren - Tillis Engineers	Project No. 101.22	Plate No. 8

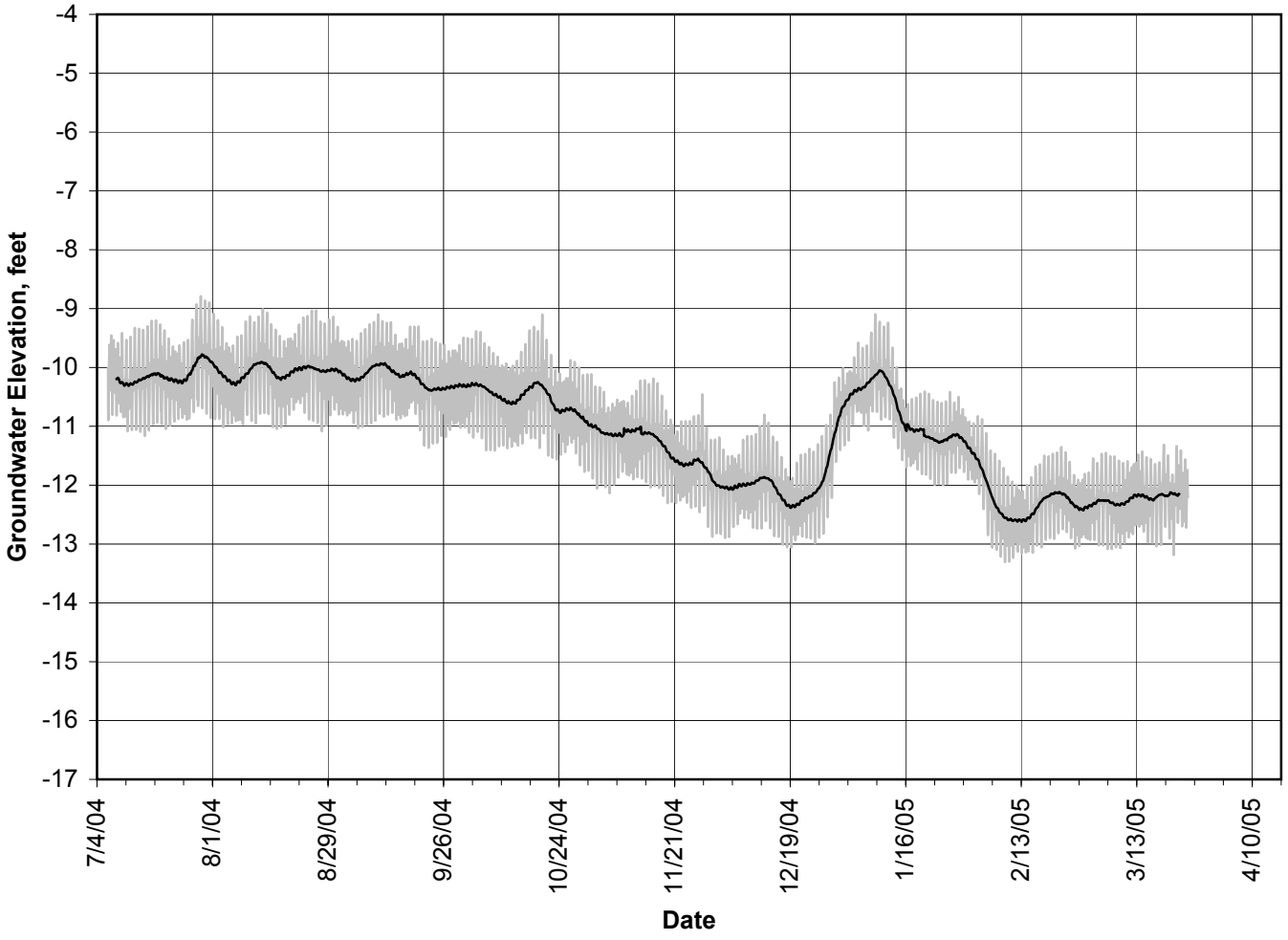
Piezometer - Bacon Island - BA-35



Groundwater Monitoring *Jones Tract Flood* *Sacramento-San Joaquin Delta, California*	**Groundwater Data at Piezometer BA-35**

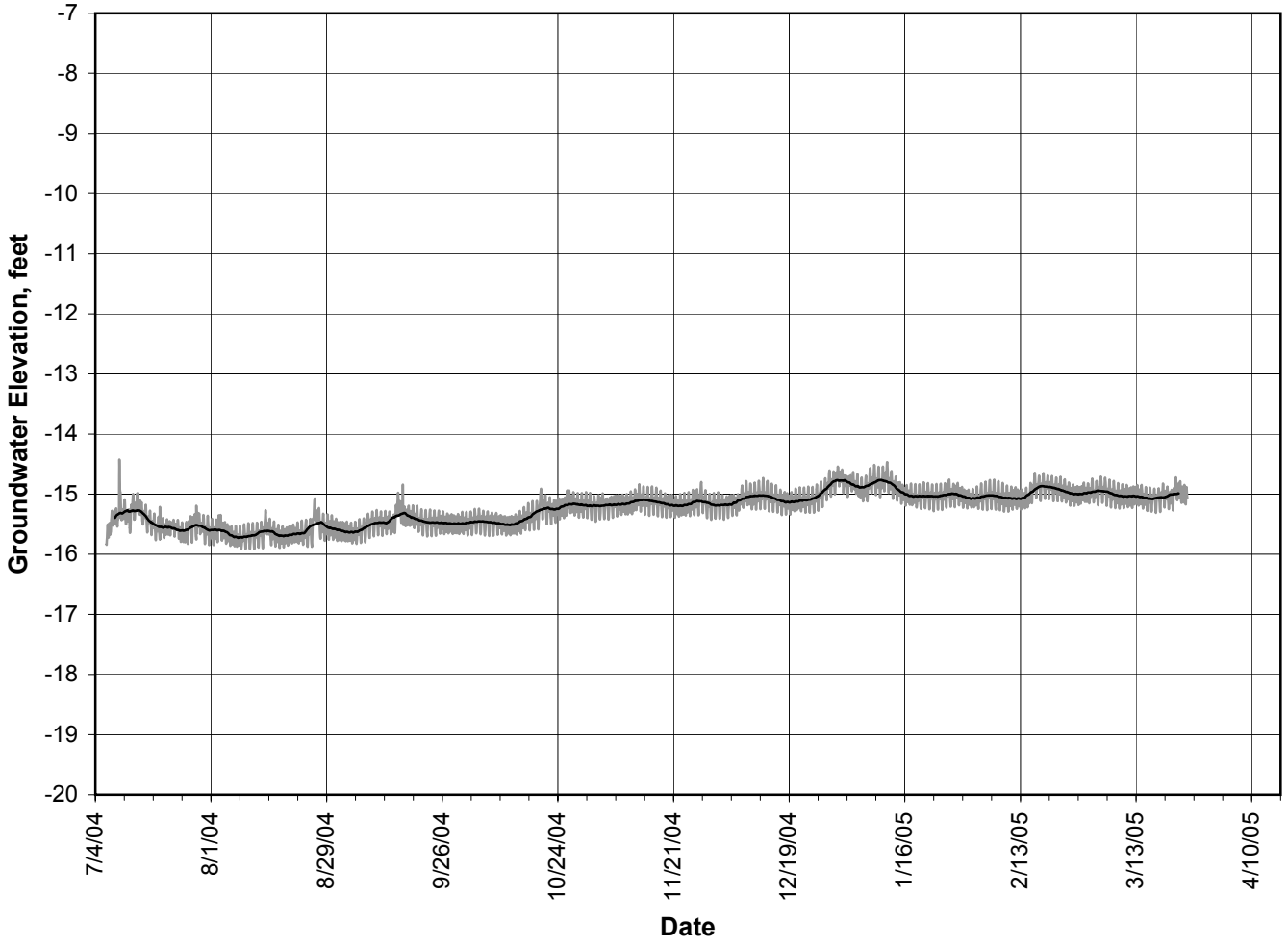
Hultgren - Tillis Engineers	Project No. 101.22	Plate No. 9

Piezometer - Woodward Island - WO-26



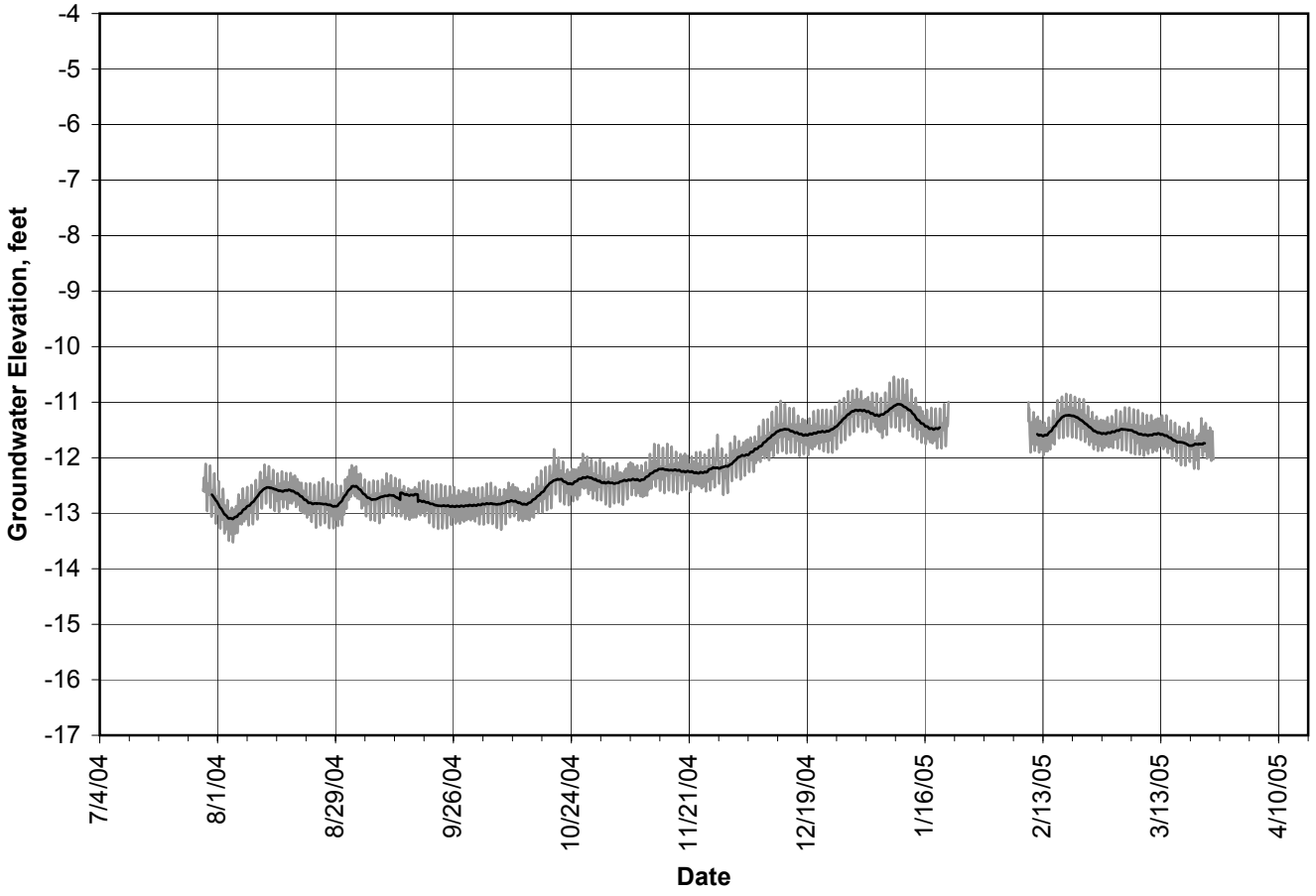
Groundwater Monitoring *Jones Tract Flood* *Sacramento-San Joaquin Delta, California*	**Groundwater Data at Piezometer WO-26**	
Hultgren - Tillis Engineers	Project No. 101.22	Plate No. 10

Piezometer - Woodward Island - WO-27



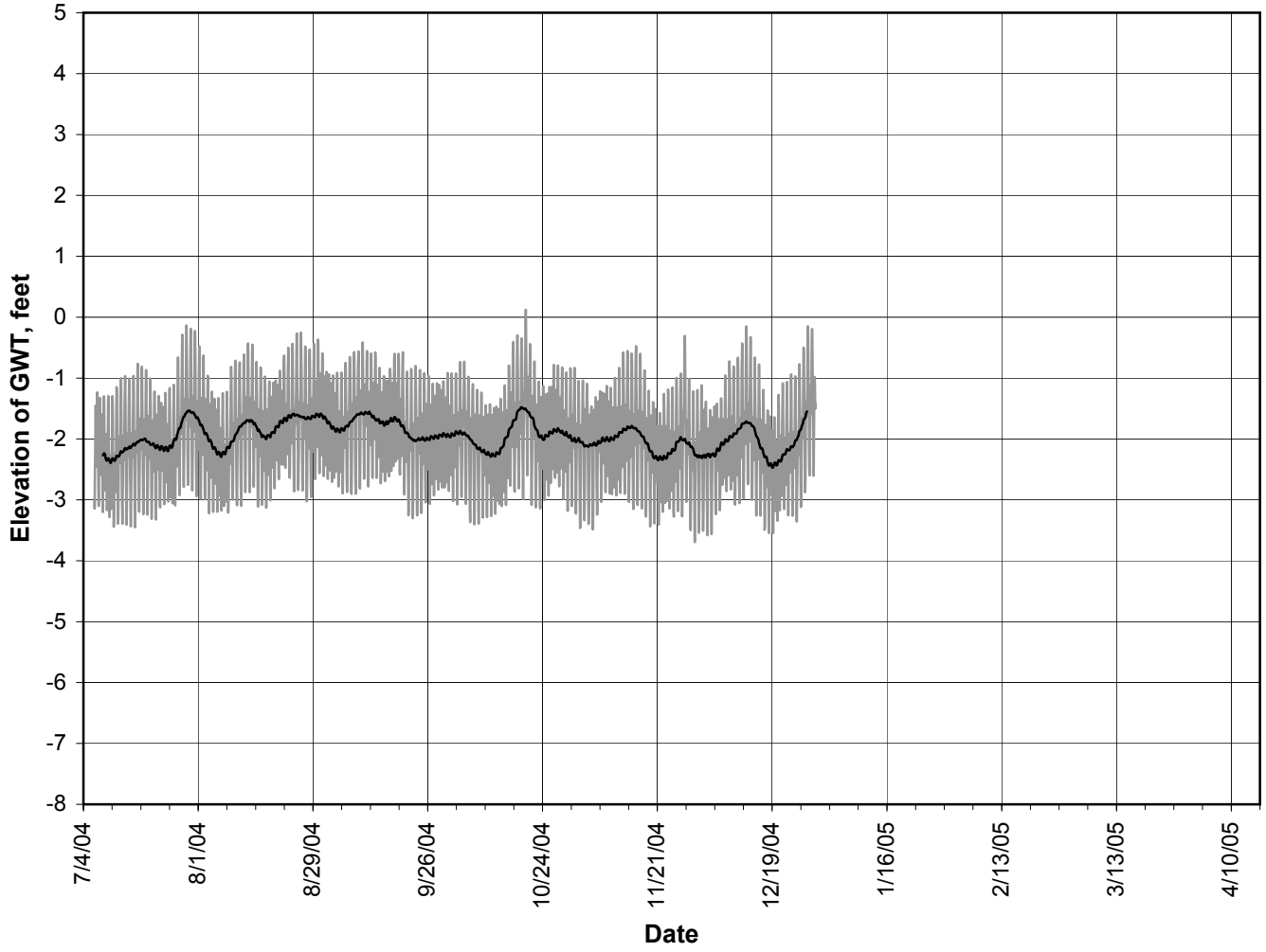
Groundwater Monitoring *Jones Tract Flood* *Sacramento-San Joaquin Delta, California*	**Groundwater Data at Piezometer WO-27**	
Hultgren - Tillis Engineers	Project No. 101.22	Plate No. 11

Piezometer - Palm Tract - PA-29



Groundwater Monitoring *Jones Tract Flood* *Sacramento-San Joaquin Delta, California*	**Groundwater Data at Piezometer PA-29**	
Hultgren - Tillis Engineers	Project No. 101.22	Plate No. 12

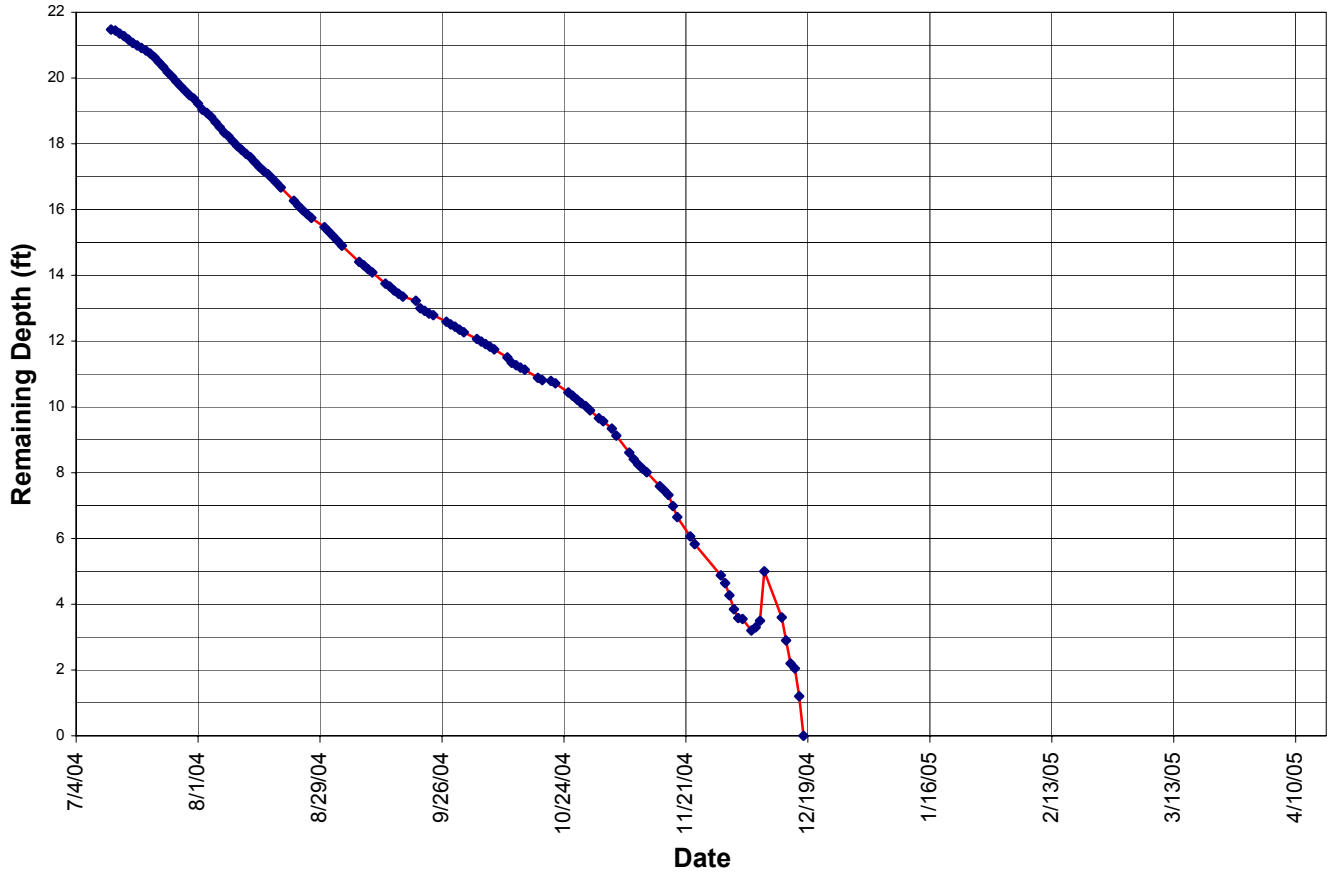
Piezometer - Palm Tract - PA-30



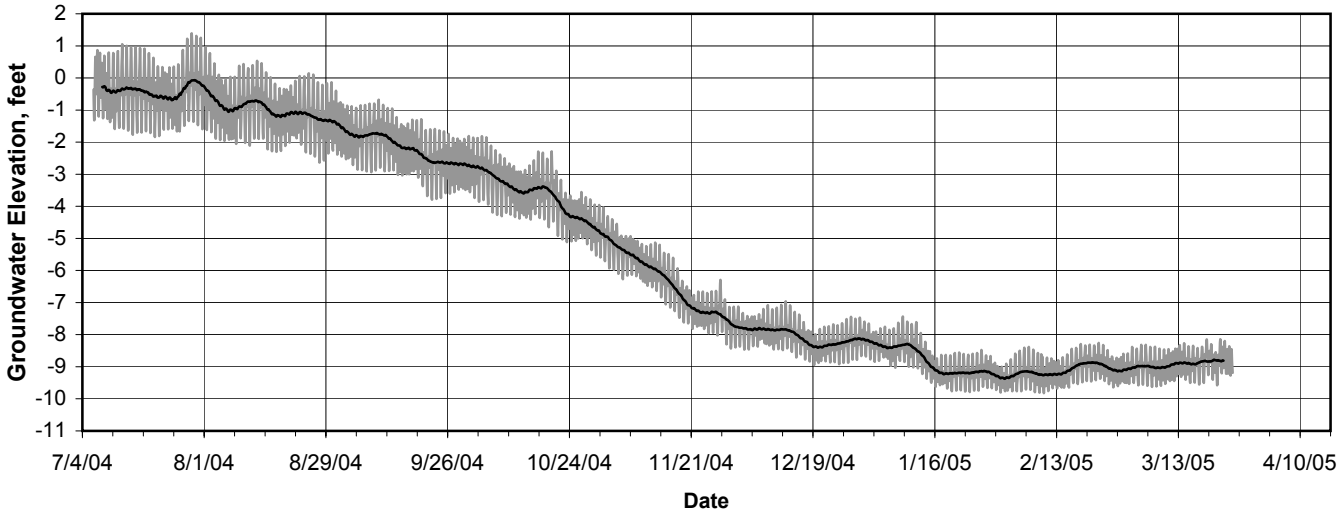
Groundwater Monitoring *Jones Tract Flood* *Sacramento-San Joaquin Delta, California*	**Groundwater Data at Piezometer PA-30**

Hultgren - Tillis Engineers	Project No. 101.22	Plate No. 13

Jones Tract Water Level

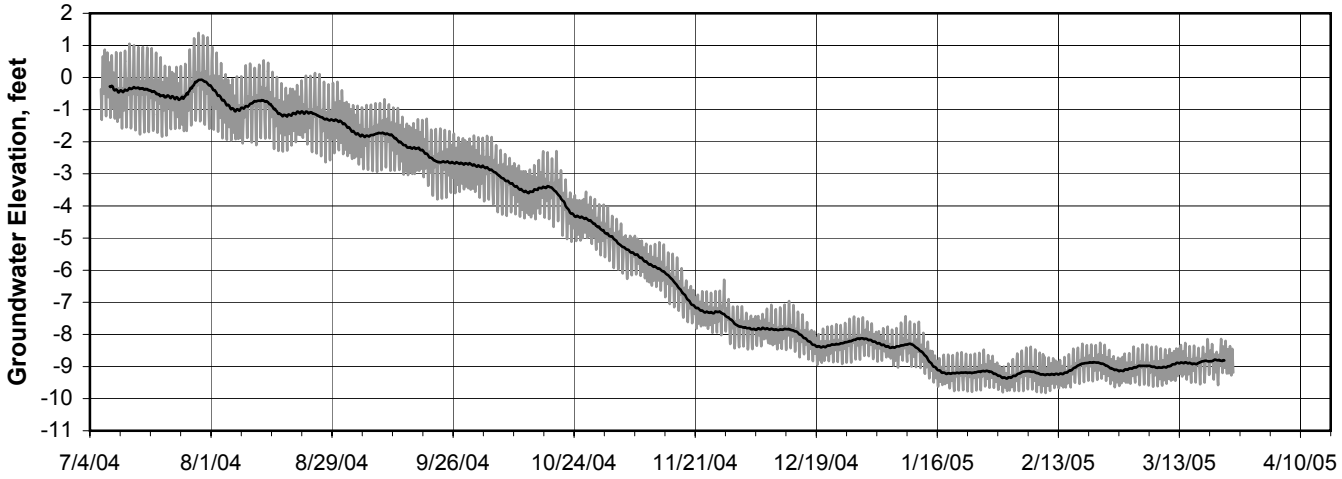


Piezometer - Upper Jones Tract - UJ-21

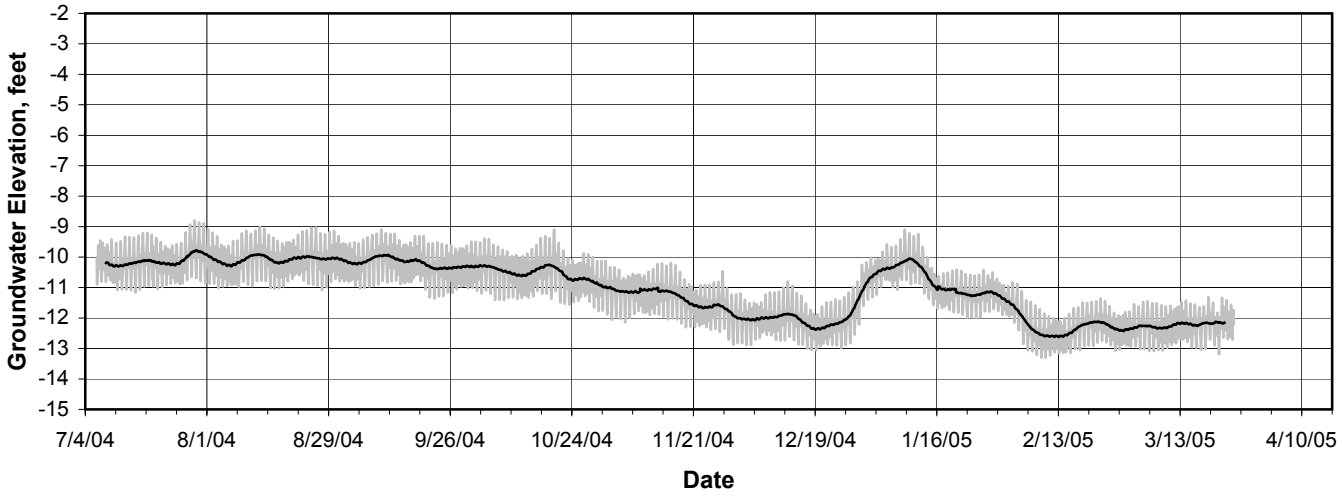


Groundwater Monitoring *Jones Tract Flood* *Sacramento-San Joaquin Delta, California*	**Groundwater Level Comparison Charts**	
Hultgren - Tillis Engineers	Project No. 101.22	Plate No. 14

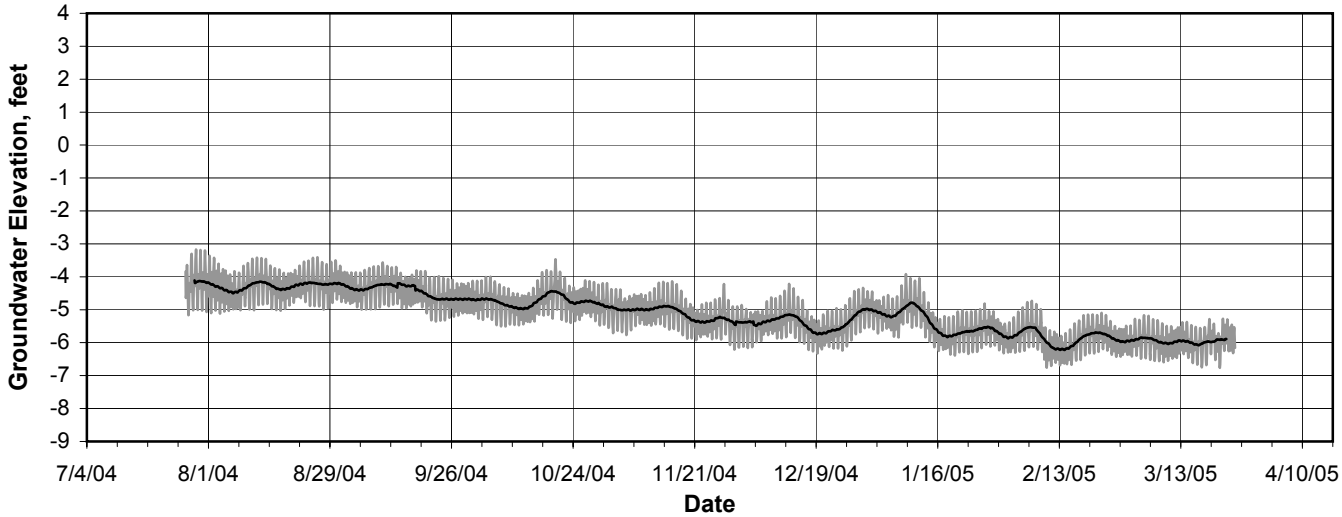
Piezometer - Upper Jones Tract - UJ-21



Piezometer - Woodward Island - WO-26

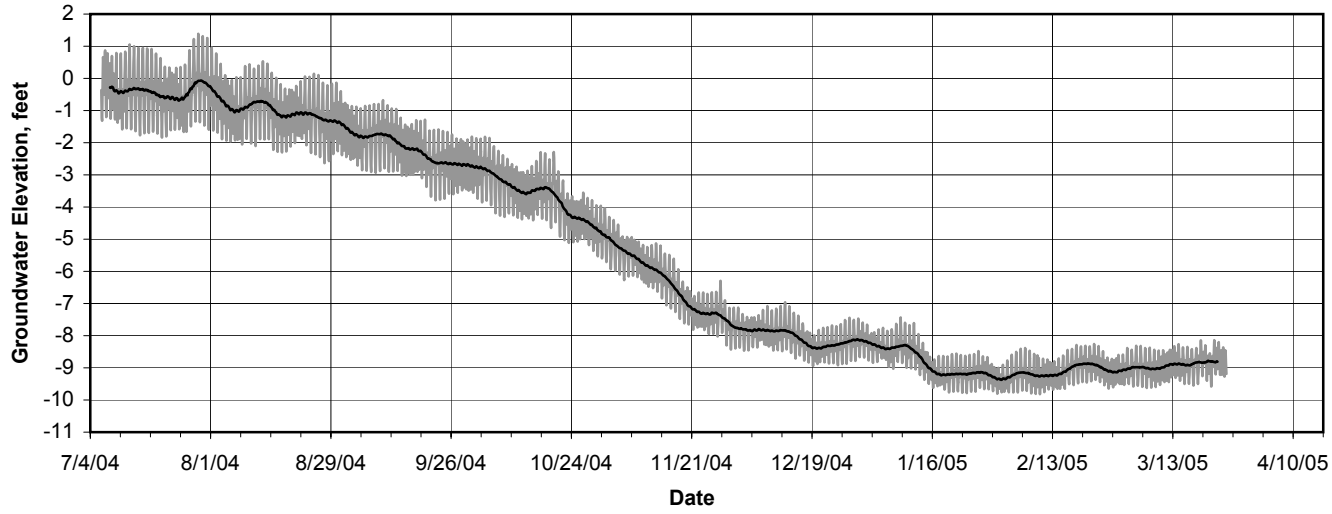


Piezometer - Bacon Island - BA-35

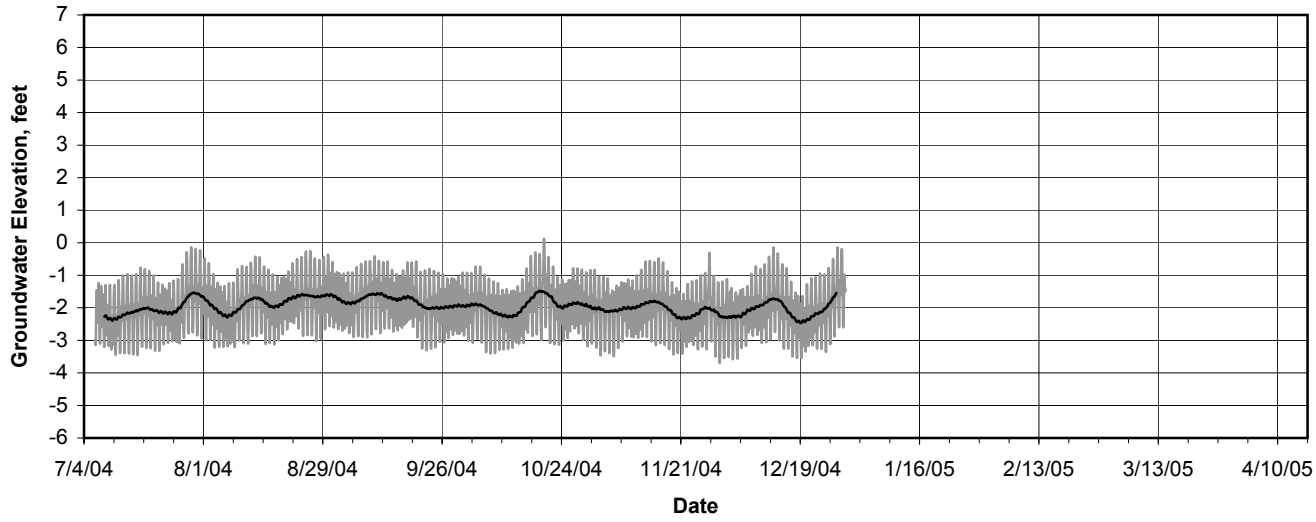


Groundwater Monitoring *Jones Tract Flood* *Sacramento-San Joaquin Delta, California*	**Groundwater Level Comparison Charts**
Hultgren - Tillis Engineers	Project No. 101.22 / Plate No. 15

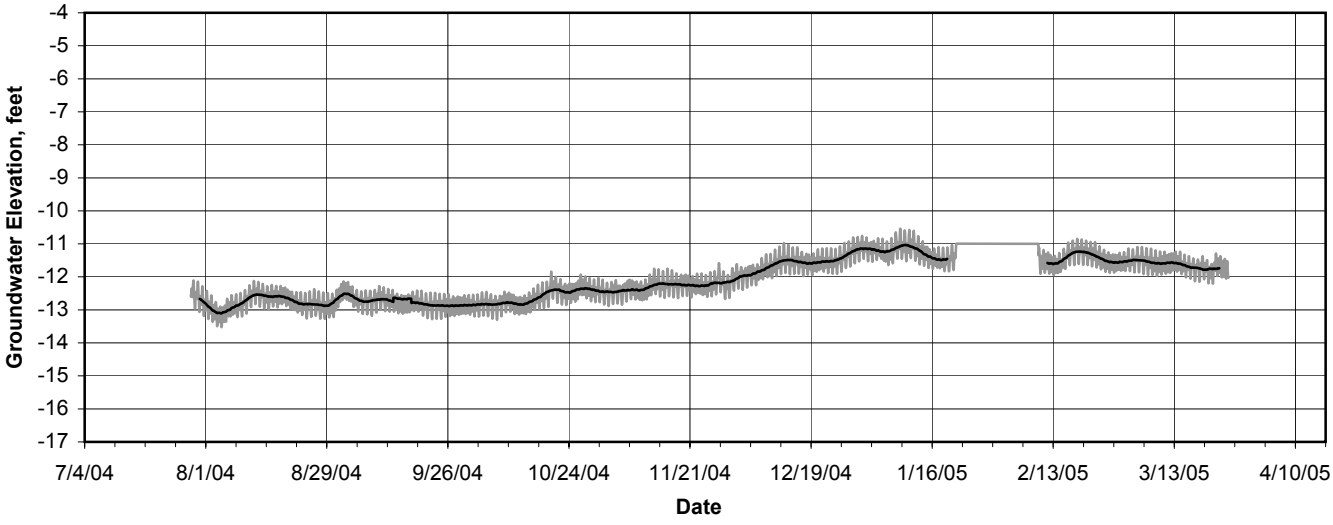
Piezometer - Upper Jones Tract - UJ-21



Piezometer - Palm Tract - PA-30



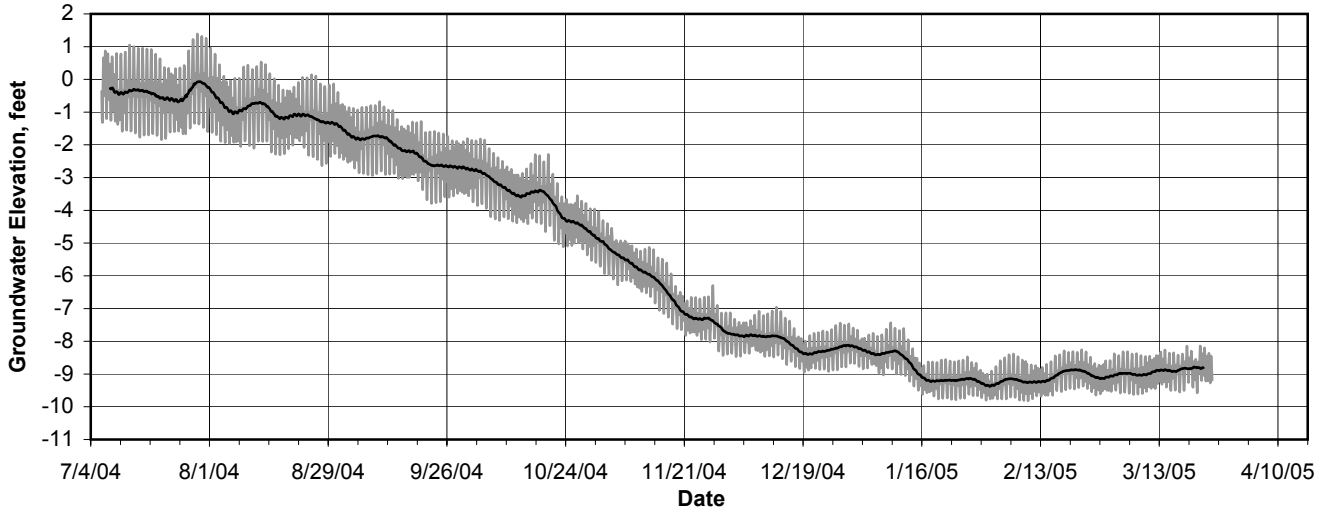
Piezometer - Palm Tract - PA-29



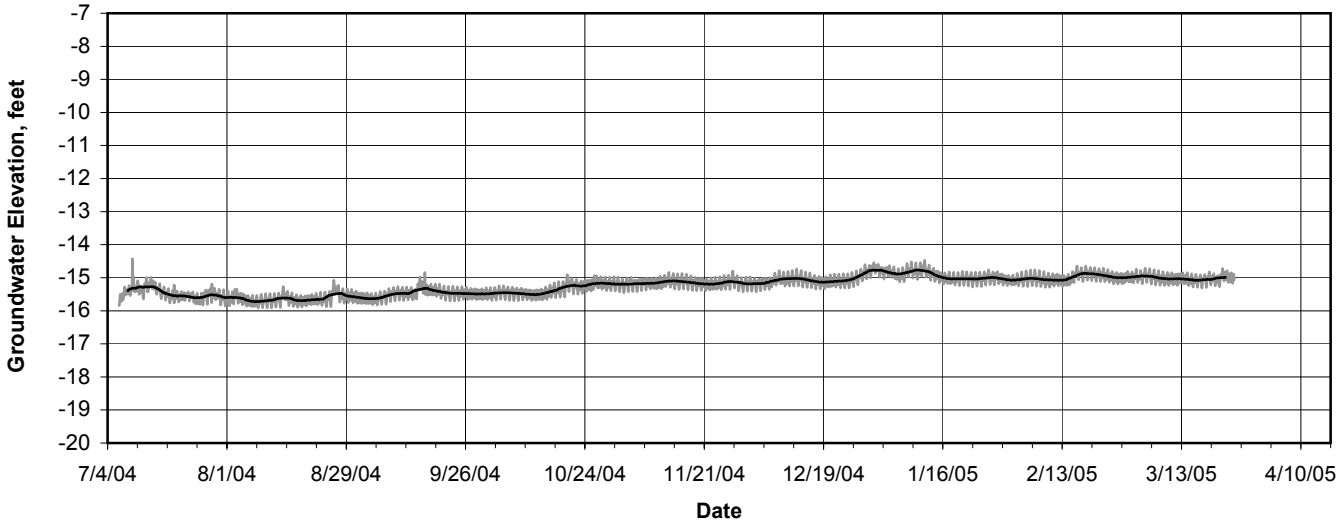
Groundwater Monitoring *Jones Tract Flood* *Sacramento-San Joaquin Delta, California*	**Groundwater Level Comparison Charts**

Hultgren - Tillis Engineers	Project No. 101.22	Plate No. 16

Piezometer - Upper Jones Tract - UJ-21



Piezometer - Woodward Island - WO-27



Groundwater Monitoring *Jones Tract Flood* *Sacramento-San Joaquin Delta, California*	**Groundwater Level Comparison Charts**

Hultgren - Tillis Engineers	Project No. 101.22	Plate No. 17